Terminator I/O
MODBUS
Base Controller
User Manual

Manual Number T1K–MODBUS–M

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Manual Revisions

If you contact us in reference to this manual, be sure to include the revision number.

Title: Terminator I/O MODBUS Base Controller User Manual
Manual Number: T1K–MODBUS–M

Edition	Date	Description of Changes
1st Edition	08/01	Original Issue

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Introduction

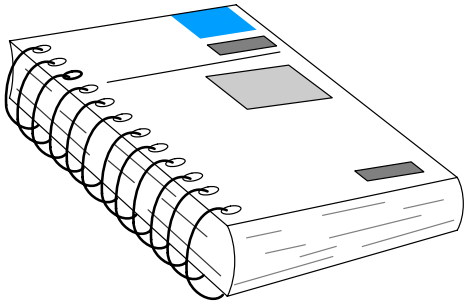
In This Chapter. . . .

- Manual Overview
- Introduction to MODBUS
- Terminator I/O System
- T1K–MODBUS Base Controller

Manual Overview

The Purpose of this Manual

This manual describes the installation and operation of the Terminator I/O MODBUS Base Controller (T1K–MODBUS).



Supplemental Manuals

The following manuals are essential to the proper use of your Terminator I/O MODBUS Base Controller.

- Terminator Installation and I/O Manual part number **T1K–INST–M**

  This manual contains very important information, including a complete I/O Module Memory Map. The Memory Map is crucial in designing and implementing a Terminator I/O system.
- The PLC User Manual (if PLC is used as master).
- The MODBUS Master manual (if other than PLC is used as master).

Who Should Read this Manual

If you have a working knowledge of MODBUS networks, and the PLC or PC which you are using, this manual will help you configure and install your T1K–MODBUS Base Controller.

Technical Support

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Manual Layout The contents of this user manual are as follows:

Chapter	Title	What's covered
1	**Introduction**	introduces MODBUS and describes both the Terminator I/O System and the T1K–MODBUS Base Controller
2	**T1K–MODBUS Specifications**	provides module specifications, dip switch settings, port pin–outs and wiring information.
3	**MODBUS RTU Functions and Addressing Modes**	provides MODBUS RTU functions supported and use with DirectLogic PLCs, or MODBUS 584/984 modes.
4	**Using T1K–MODBUS Setup Tool**	explains how to configure the MODBUS port using the Setup Tool.

Appendices Additional reference information for the T1K–MODBUS is available in the following appendices.

Appendix	Title	What's covered
A	**I/O Module Hot Swap**	explains the T1K–MODBUS I/O module Hot Swap feature and the Enable/Disable Outputs switch.
B	**Analog Output Module Configuration**	uses a memory map to explain how to configure an analog output module.

Symbols Used

The "note pad" icon in the left–hand margin indicates a **special note**.

The "exclamation mark" icon in the left-hand margin indicates a **warning** or **caution**. These are very important because the information may help you prevent serious personal injury or equipment damage.

The "light bulb" icon in the left-hand margin indicates a **tip** or **shortcut**.

Introduction to MODBUS

MODBUS RTU (Remote Terminal Unit) Protocol is a messaging structure used to establish master–slave communications between intelligent devices. When a MODBUS master sends a message to a MODBUS slave, the message contains the address of the slave, the function, the data and a check sum. The slave's response message contains fields confirming the master's request, any data requested and an error–checking field.

A typical MODBUS RTU frame consists of the following fields:

ADDRESS	FUNCTION	DATA	CHECKSUM

The **address field** of a message contains 8 bits. Valid slave addresses are in the range of 0– 247 decimal. The individual slave devices are set in the range of 1 – 247 decimal (address 0 is the broadcast to all slaves address). The master specifies a slave by placing the slave address in the address field of the message. When the slave responds, it places its own address in the address field to identify to the master which slave is responding.

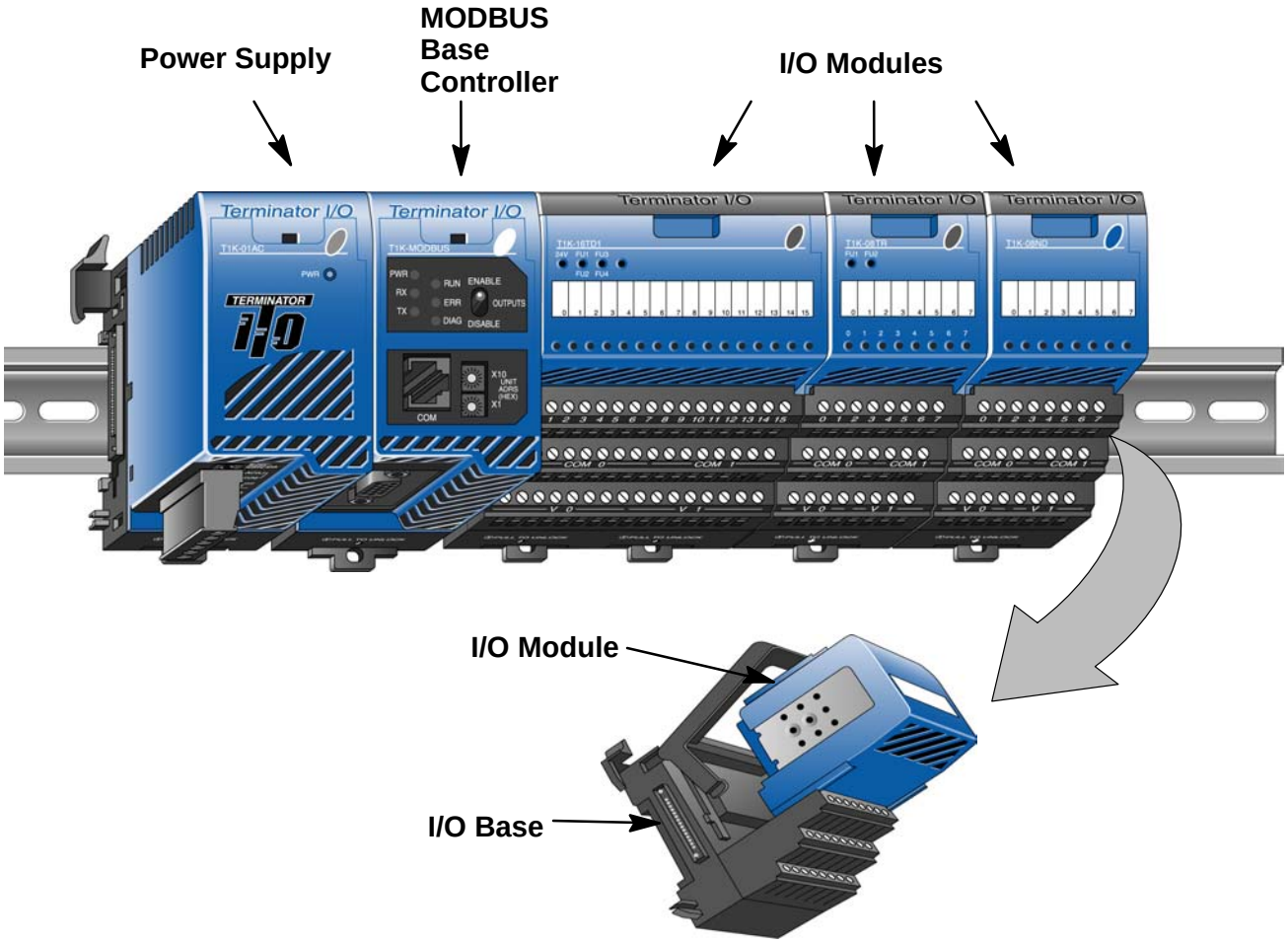
The **function code field** of a message contains 8 bits. Valid function codes are in the range of 1 – 255 decimal. The function code instructs the slave what kind of action to take. Some examples are to read the status of a group of discrete inputs; to read the data in a group of registers; to write to an output coil or a group of registers; or to read the diagnostic status of a slave.
When a slave responds to the master, it uses the function code field to indicate either a normal response or that some type of error has occurred. For a normal response, the slave echoes the original function code. In an error condition, the slave echoes the original function code with its MSB set to a logic 1.

The **data field** is constructed using sets of two hexadecimal digits in the range of 00 to FF. According to the network's serial transmission mode, these digits can be made of a pair of ASCII characters or from one RTU character.
The data field also contains additional information that the slave uses to execute the action defined by the function code. This can include internal addresses, quantity of items to be handled, etc.
The data field of a response from a slave to a master contains the data requested if no error occurs. If an error occurs, the field contains an exception code that the master uses to determine the next action to be taken. The data field can be nonexistent in certain types of messages.

The **checksum field** is used for error checking. Standard MODBUS serial networks use two types of error checking.
Parity checking (even or odd) totals the number of logical 1 bits in the data field and sets the parity bit to a 0 or 1 representing an odd or even total of logical 1 bits. *Cyclical Redundancy Check* (CRC) checks the entire message and is applied regardless of any parity check method used. The CRC field consists of two bytes, creating a 16 bit binary value. The CRC is calculated in the transmitting device and is recalculated and compared by the receiving device.
Both the character check and the message frame check are generated in the master device and applied to the message before transmission. The slave device checks each character and the entire message frame during receipt.

Terminator I/O System

Terminator I/O is a modular system which combines the functions of terminal blocks and I/O modules for distributed I/O. Each Terminator I/O system has the following components: a Power Supply, a Base Controller, and one or more I/O Modules and I/O bases.



T1K–MODBUS Base Controller

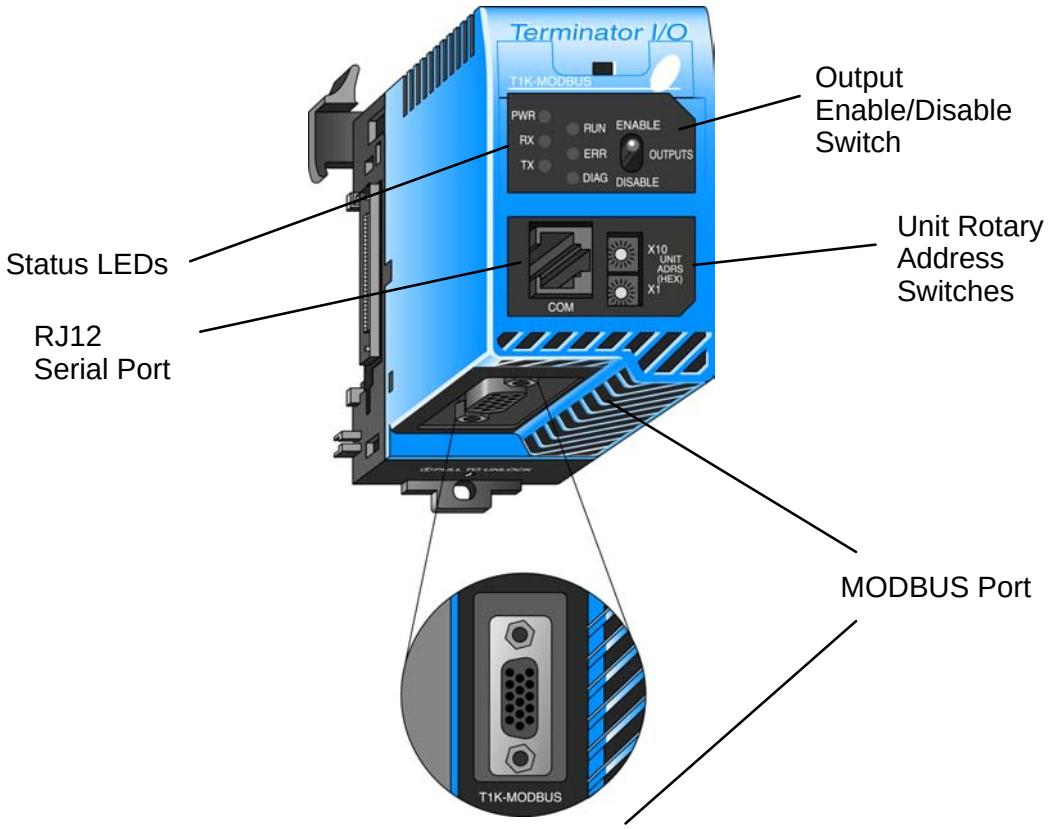
The T1K–MODBUS Base Controller is a slave module that functions as a controller for Terminator I/O on a MODBUS network.

Note: It is recommended to use the T1K–MODBUS Base Controller in a “scan based” (polled) control system rather than in an “event–driven” control system. As a slave, the Base Controller does not have the ability to report an error condition to the MODBUS network master. Thus, polling a slave on a regular basis will detect a slave error condition promptly, whereas an event–driven control system will not detect a slave error condition until the next event is addressed to a slave in error.

MODBUS Base Controller Features

The Base Controller has the following features:

- Status LEDs
- MODBUS Port
- Serial Port (RJ12)
- Unit Address Switches
- Output Enable/Disable Switch
- DIP Switch (located on right side of unit)



2

T1K–MODBUS Base Controller Specifications

In This Chapter. . . .

— T1K–MODBUS Base Controller Specifications
— Setting the DIP Switches
— Setting the Rotary Address Switches
— MODBUS Port Pin–out and Wiring
— RJ12 Serial Port Pin–out and Wiring

T1K–MODBUS Base Controller Specifications

General	
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	–4° F to 158° F (–20° C to 70° C)
Ambient Humidity	30% – 95% relative humidity (non–condensing)
Voltage Withstand	1500VAC, 1 minute (15–pin connector internal)
Insulation Resistance	500VDC, 10MΩ
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Noise Immunity	NEMA (ICS3–304) Impulse noise 1µs, 1000V FCC class A RFI (145MHz, 435MHz 10W, 10cm)
Atmosphere	No corrosive gases Environmental Pollution Level is 2.
Size	1.89”Wx3.15”Hx3.26”D (48Wx80Hx83D)mm
Weight	6.0 oz. (170 g)

MODBUS Port Specifications	
Connector	15–pin female D–shell connector
Connection Port Type	RS232C, RS–422/485
Protocol	MODBUS RTU
Station Number	1 to F7h (247) Rotary Switch Setting
Number of I/O Points	Inputs: 1024; Outputs: 1024
Baud Rate	300bps, 600bps, 1200bps, 2400bps, 4800bps, 9600bps, 19200bps (Dip Switch 1–3 selectable)
Communication Data	8 Bit (Fixed)
Start Bit	1 Bit (Fixed)
Stop Bit	1 Bit (Default), 2 Bit Selectable with Dip Switch 4 ON (Option Mode) Use T1K–MODBUS Setup Tool
Parity Bit	ODD (Default) / EVEN / NONE; Selectable with Dip SW 4 ON (Option Mode) Use T1K–MODBUS Setup Tool
Communication Timeout	500ms, 1s (Default), 2.5s, 5s, 10s, 25s, 60s Selectable with Dip SW 4 ON (Option Mode) Use T1K–MODBUS Setup Tool
RTS On / RTS Off Delay Time	0 (Default) / 2 / 5 / 10 /50 /100 / 500 ms Selectable with Dip SW 4 ON (Option Mode) Use T1K–MODBUS Setup Tool
Communication Status Indicators	RUN, ERR, TX, RX
Module Status Indicators	PWR, DIAG

RJ12 Serial Port Specifications	
Connector	6–pin female modular (RJ12 phone jack)
Connection Port Type	RS232C
Protocol	MODBUS RTU; Use to configure the MODBUS port using the T1K–MODBUS Setup Tool. Also use for firmware upgrades.
Station Number	1 (Fixed)
Baud Rate	9600bps, 19200bps (Dip Switch 6 selectable)
Communication Data	8 Bit (Fixed)
Start Bit	1 Bit (Fixed)
Stop Bit	1 Bit (Fixed)
Parity Bit	ODD (Fixed)

Base Controller I/O Specifications	
Number of I/O Points (max.)	Discrete: Inputs: 1024, Outputs: 1024 Analog: Inputs 64 Channels, Outputs 64 Channels
Number of Slots	1 to 31
Self–Diagnostics	Watchdog Timer, Memory Check
I/O Module Type Supported	Discrete Input, Discrete Output Analog Input, Analog Output
Hot Swap	Yes
Internal Power Consumption	250mA @ 5VDC
Allowable External Power Drop	to 0V for 10ms max.

Status Indicators

The status indicator LEDs on the Base Controller's front panel have specific functions which can help in programming and troubleshooting.

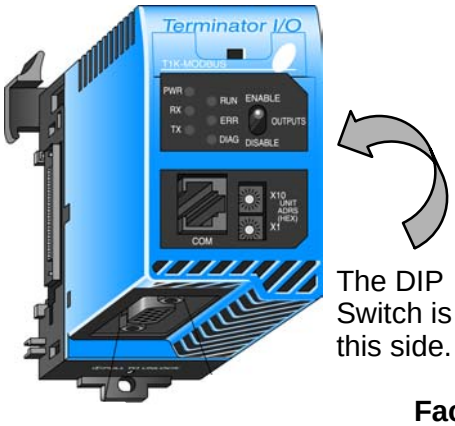
Indicator	Status	Description
PWR (Green)	ON	Power good
RX (Green)	ON	Data is being received by the Base Controller
	OFF	No data is being received by the Base Controller
TX (Green)	ON	Data is being transmitted by the Base Controller
	OFF	No data is being transmitted by the Base Controller
RUN (Green)	ON	Starting communication to Master Module
	OFF	LED will turn OFF 1 second after failing to communicate with master module
ERR	ON	Communication error
	Flashing at 1 sec intervals	ERR LED will begin flashing after the master stops communicating with the Base Controller. The Communication Time–out period can be set using the T1K–MODBUS Setup Tool.
DIAG	ON	I/O system error
	OFF	I/O sytem good

Setting the DIP Switches

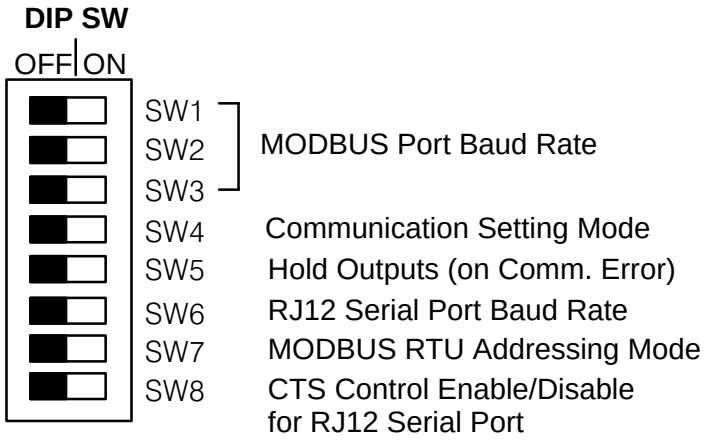
DIP Switch Settings

The T1K–MODBUS controller has an eight position DIP Switch which controls baud rates, addressing modes, the state of the outputs in an error condition, etc. The DIP Switch is located on the side of the unit, opposite the power supply.

Note: Be sure to look closely at the DIP Switch default settings below.



The DIP Switch is on this side.



Factory Default Settings Shown (all OFF)

DIP Switches 1–3 select the MODBUS port baud rate.

SW 1–3 MODBUS Port Baud Rate			
Baud Rate	**SW 1**	**SW2**	**SW3**
300 bps	OFF	OFF	OFF
600 bps	ON	OFF	OFF
1200 bps	OFF	ON	OFF
2400 bps	ON	ON	OFF
4800 bps	OFF	OFF	ON
9600 bps	ON	OFF	ON
19200 bps	OFF	ON	ON
38400 bps	ON	ON	ON

The Communications Setting mode, **DIP Switch 4**, enables some of the MODBUS port communication parameters to be user set using the T1K–MODBUS Set Up Tool. The following tables describe the default and option modes.

SW 4 Communication Setting Mode	
OFF	Default Mode
ON	Option Mode

Default Mode:
The following table lists the MODBUS port default settings when **DIP Switch 4 is in the OFF position.**

SW 4 OFF	MODBUS Port / Default Mode
Item	**Default Setting**
Communication Data	8 Bit
Start Bit	1 Bit
Stop Bit	1 Bit
Parity Bit	ODD
Communication Timeout	1s
RTS ON Delay Time	0ms
RTS OFF Delay Time	0ms

Option Mode:
The following items are user selectable using the T1K–MODBUS Set Up Tool* when **DIP Switch 4 is in the ON position**.

SW 4 ON	MODBUS Port / Option Mode
Item	**Default Setting**
Communication Data	8 Bit (Fixed)
Start Bit	1 Bit (Fixed)
Stop Bit*	1 Bit / 2 Bit
Parity Bit*	ODD / EVEN / NONE
Communication Timeout*	500ms, 1s, 2.5s, 5s, 10s, 25s, 60s
RTS ON Delay Time*	0ms, 2ms, 5ms, 10ms, 20ms, 50ms, 100ms, 500ms
RTS OFF Delay Time*	0ms, 2ms, 5ms, 10ms, 20ms, 50ms, 100ms, 500ms

The Hold Outputs DIP Switch 5 determines the slave outputs' response to a communications failure. If DIP switch 5 is in the ON position, the outputs in that slave unit will hold their last state when a communication error occurs. If OFF, the outputs in that slave unit will turn off in response to a communications error.

SW 5 Hold Outputs	
OFF	Turn OFF
ON	Hold Last State

WARNING: Selecting "HOLD LAST STATE" means that outputs in that slave will not be under program control in the event of a communications failure. Consider the consequences to process operation carefully before selecting this mode.

DIP Switch 6 selects the baud rate for the RJ12 serial port. All other serial port communication parameters are fixed. The port defaults are listed in the specifications tables in the beginning of this chapter.

SW 6 RJ12 Serial Port Baud Rate	
OFF	9600 bps
ON	19200 bps

DIP Switch 7 selects the T1K–MODBUS addressing mode. Select the **OFF position** if the T1K–MODBUS is to be used with a MODBUS master that operates in the 584/984 addressing mode. Select the **ON position** if the T1K–MODBUS is to be used with a ***Direct***Logic PLC CPU operating as the MODBUS master. The modes are discussed in Chapter 3.

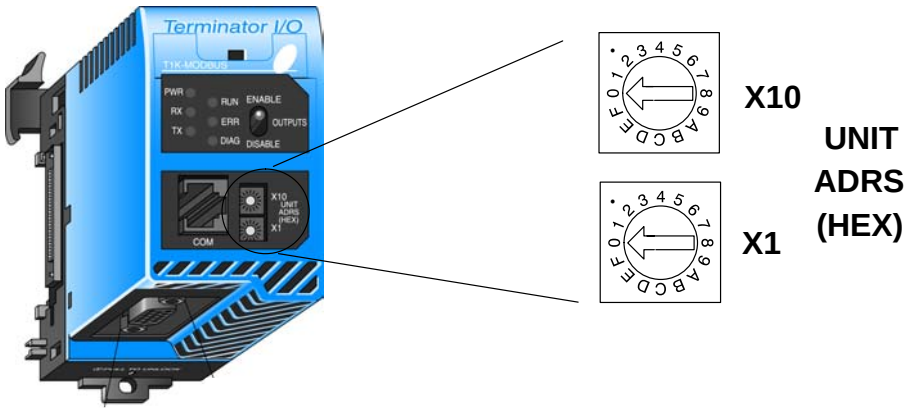
SW 7 MODBUS RTU Addressing Mode	
OFF	584/984 MODBUS Slave
ON	***Direct***Logic PLC MODBUS Slave

DIP Switch 8 either enables or disables the CTS pin on the RJ12 serial port. Place the switch in the **ON position** if the connected serial device requires RTS/CTS control. Otherwise place the switch in the **OFF position** if only 3–wire communication (TX, RX, GND) is required.

SW 8 CTS for RJ12 Serial Port	
OFF	Disable
ON	Enable

Setting the Rotary Address Switches

The T1K–MODBUS unit address is set by the two rotary switches on the front of the unit. Addresses are in hexadecimal format with valid address from 00 to F7, which is equivalent to 0 to 247 decimal. The addresses do not have to be sequential, but each station address must be unique.
The top rotary switch is used to set the most significant digit of the HEX address. The lower switch is used to set the least significant digit in the HEX address.



Converting HEX Addresses to Decimal

Eventhough the T1K–MODBUS unit address is set in HEX, it's not difficult to calculate the equivalent decimal address used by the MODBUS protocol.
To calculate the equivalent HEX address:
1) Divide the decimal address desired by 16. This provides the X10 HEX digit.
2) The remainder will be a number less than 16, resulting in a HEX number between 0–F. The remainder provides the X1 HEX digit. Two examples are given below.

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	HEX Format
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Decimal format

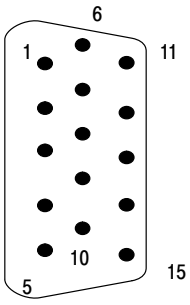
60 decimal

60 ÷ 16 = 3 with remainder of 12 = C So 60 decimal = 3C HEX

24 decimal

24 ÷ 16 = 1 with remainder of 8 = 8 So 24 decimal = 18 HEX

MODBUS Port Pin–out and Wiring

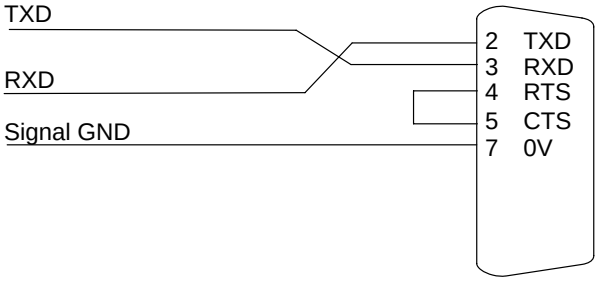


15-pin Female
D Connector

MODBUS Port Pin Descriptions		
1	5V	5 VDC
2	TXD2	Transmit Data (RS232C)
3	RXD2	Receive Data (RS232C)
4	RTS2	Ready to Send (RS–232C)
5	CTS2	Clear to Send (RS–232C)
6	RXD2–	Receive Data – (RS–422)
7	0V	Logic Ground
8	0V	Logic Ground
9	TXD2+	Transmit Data + (RS–422)
10	TXD2 –	Transmit Data – (RS–422)
11	RTS2 +	Request to Send + (RS–422)
12	RTS2 –	Request to Send – (RS–422)
13	RXD2 +	Receive Data + (RS–422)
14	CTS2 +	Clear to Send + (RS422)
15	CTS2 –	Clear to Send – (RS–422)

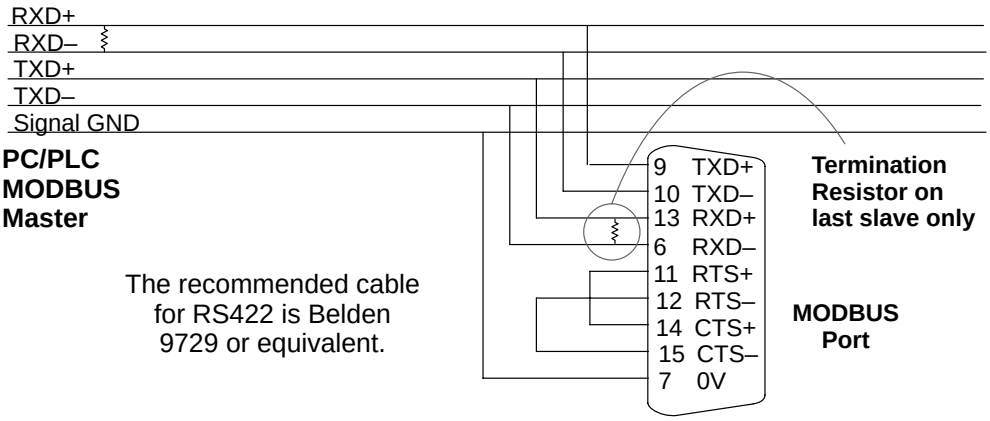
RS–232C Point-to-point DTE Device

PC/PLC MODBUS Master



MODBUS Port

RS–422 Network



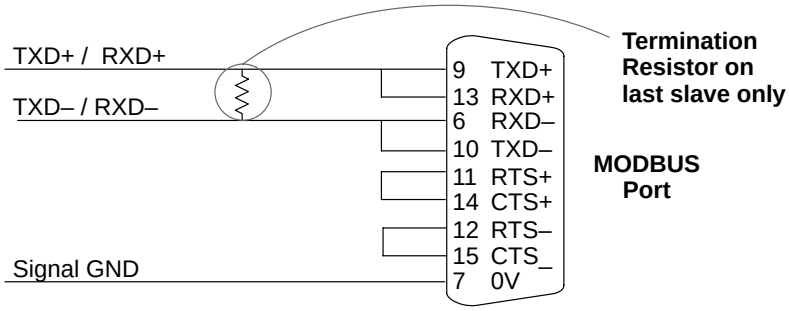
PC/PLC MODBUS Master

Termination Resistor on last slave only

MODBUS Port

The recommended cable for RS422 is Belden 9729 or equivalent.

RS–485 Network



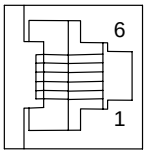
PC/PLC MODBUS Master

Termination Resistor on last slave only

MODBUS Port

RJ12 Serial Port Pin–out and Wiring

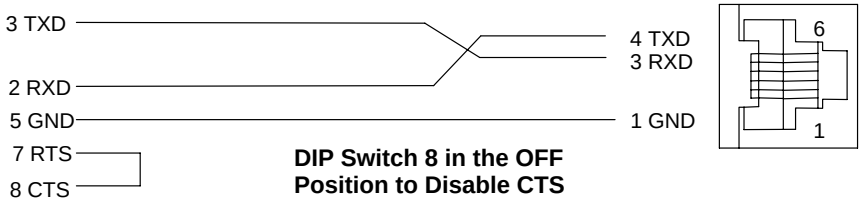
The Base Controller's MODBUS port can be configured using the T1K–MODBUS Setup Tool via the RJ12 serial port. The "Using the T1K–MODBUS Setup Tool" chapter later in this manual discusses using the Setup Tool. The RJ12 port is also used to upgrade the firmware in the base controller.



6-pin Female
Modular Connector

RJ12 Serial Port Pin Descriptions		
1	0V	Power (–) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive Data (RS232C)
4	TXD	Transmit Data (RS232C
5	RTS	Request to Send
6	CTS	Clear to Send

Use D2–DSCBL to connect PC to RJ12 Serial Port



DIP Switch 8 in the OFF Position to Disable CTS

3

MODBUS RTU Functions and Addressing Modes

In This Chapter. . . .

— T1K–MODBUS RTU Function Codes
— Using T1K–MODBUS with ***Direct***Logic PLC
— Using T1K–MODBUS with MODBUS 584/984

MODBUS RTU Function Codes

MODBUS Function Codes Supported

The following MODBUS RTU functions are supported by the T1K–MODBUS base controller.

MODBUS RTU Function Code	Function
01	Read Output Table
02	Read Input Table
03	Read Holding Registers (when addressing mode is 584/984, this function is used to access analog output registers)
04	Read Input Registers (when addressing mode is 584/984, this function is used to access analog input registers)
05	Force Single Output
06	Preset Single Registers
07	Read Exception Status
08	Loop back / Maintenance
09 – 14	–
15	Force Multiple Outputs
16	Preset Multiple Registers
17	Report Device Type
18 – 64	–
65	not supported
66	not supported
68–70	not supported
72	not supported
73 – 127	–

*Direct*Logic Addressing Mode

Using the T1K–MODBUS with a *Direct*Logic PLC Modbus Master

The ***Direct***Logic Addressing mode is set by placing **Dip Switch 7 in the ON position**. The following memory locations are supported by the T1K–MODBUS base controller in the ***Direct***Logic Addressing Mode.

- X0 – X1777 Discrete Inputs
- Y0 – Y1777 Discrete Outputs
- V0 – V177 Analog Inputs
- V1400 – V1577 Analog Outputs

T1K–Modbus Memory Type	QTY. (Dec.)	PLC Range (Octal)	V Memory Range
For Discrete Data Type			
Inputs (X)	1024	X0 – X1777	V40400 – V40477
Outputs (Y)	1024	Y0 – Y1777	V40500 – V40577
For Word (16–bit) Data Types			
Analog Input Data Register (V)	128	V0 – V177	
Analog Output Data Registers (V)	128	V1400 – V1577	

584/984 Addressing Mode

Note: ModScan32 is a Windows based application program that can be used as a MODBUS master to access and change data points in a connected slave device (T1K–MODBUS). The utility is ideally suited for quick and easy testing of MODBUS network slave devices. Visit www.win–tech.com to download a free ModScan32 trial demo and for more information on ModScan32.

Using the T1K–MODBUS with a 584 / 984 MODBUS Master

The 584 / 984 Addressing mode is set by placing **Dip Switch 7 in the OFF position**. The following decimal memory locations are supported by the T1K–MODBUS base controller in the 584 / 984 Addressing Mode.

- 1 – 1024 Discrete Outputs
- 10001 – 11024 Discrete Inputs
- 30001 – 30128 Analog Input Registers
- 30201 – 30264 Bit Input Registers
- 40001 – 40128 Analog Output Registers
- 40201 – 40264 Bit Output Registers

Modbus Data Type		**T1K–MODBUS**			
		Range (Decimal)	**Points**		**Memory Type**
Coil		**1 – 1024**	1024		**Discrete Output**
		1025 – 9999	–		not supported
Input		**10001 – 11024**	1024		**Discrete Input**
		11025 – 19999	–		not supported
Modbus Data Type		**V Memory Range**			
		Range (Decimal)	**Words (16– bit)**	**Channel (32– bit)**	**Memory Type**
Input Register	**Analog Input**	**30001 – 30128**	128	64	Analog Input Register
	Input Register	30129 – 38999	–	–	not supported
	Bit Input Register	**30201 – 30264**	64	–	Discrete Input Bit Register
	Input Register	39129 – 39999	–	–	not supported
Hold Register	**Analog output**	**40001 – 40128**	128	64	Analog Output Register
	Hold Register	40129 – 40200	–	–	not supported
	Bit Output Register	**40201 – 40264**	64		Discrete Output Bit Register
	Hold Register	40265 – 49000	–	–	not supported
	Hold Register	49001 – 49128	128	–	Special Register
	Hold Register	49129 – 49999	–	–	not supported

4

Using the T1K–MODBUS Setup Tool

In This Chapter. . . .

— Configuring the T1K–MODBUS Port

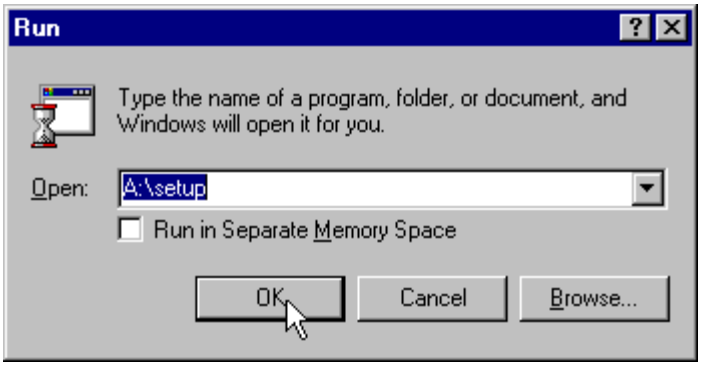
Configuring the T1K–MODBUS Port

T1K–MODBUS Setup Tool (included with this manual) can be used to configure some of the MODBUS port communication parameters via the RJ12 serial port. The T1K–MODBUS **DIP switch 4 must be in the ON position** in order to use the Setup Tool to configure the MODBUS port parameters. The configurable parameters include the Stop Bit, Parity Bit, On Delay Time, Off Delay Time and Communication Time–out. If the DIP switch is in the Off position, the factory defaults will apply. The Tool allows the T1K–MODBUS Firmware version, Rotary Address Switches and DIP switches to be read only.

Installing the Setup Tool

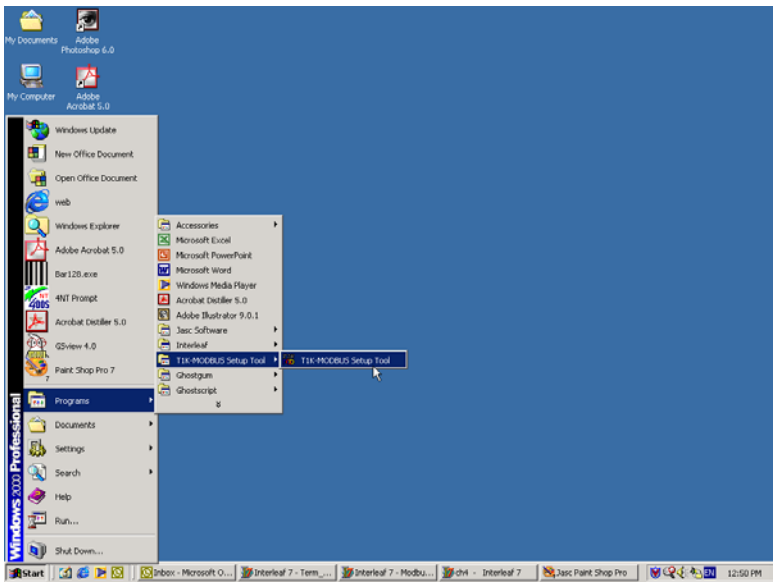
The Setup Tool can run on Windows 95/98/2000/ME™ or Windows NT™ (but not Windows 3.1x™). The Tool is included with this manual on three 3.5" diskettes. It is also available for download from the AutomationDirect web site (www.automationdirect.com). The installation process places the files in the C:\Program Files\T1K–MODBUS Setup Tool directory (default).

Place disk 1 of 3 in Drive A or Drive B. Click on the Windows Start button and then select Run. Type in the path and filename (ex. A:\setup), or click on the Browse button to find the directory and filename (ex. if the Setup Tool was downloaded from the web). A series of windows will step through the installation process for disks 1, 2 and 3.



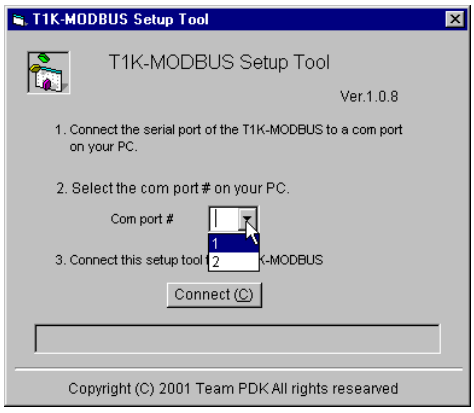
Launching the Setup Tool

Use the Windows Start menu Programs>T1K–MODBUS Setup Tool> T1K–MODBUS Setup Tool as shown below to launch the Setup Tool.



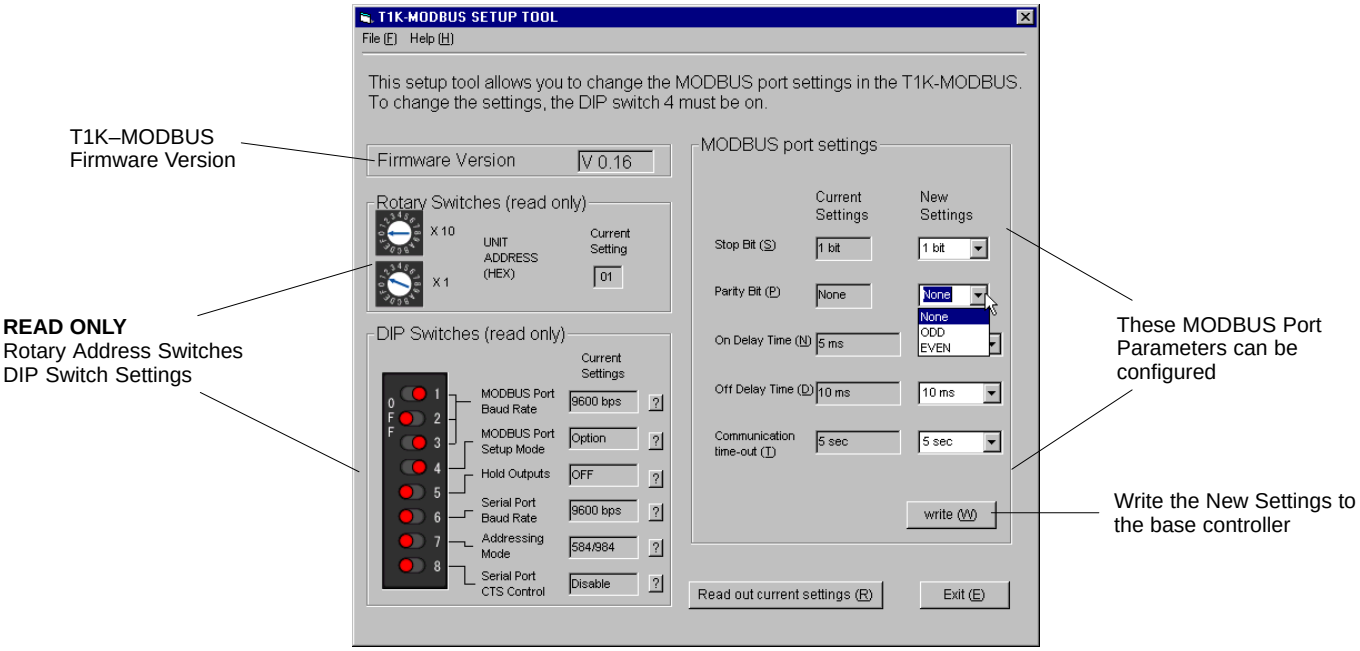
Selecting the PC Comm Port

Select the PC port that will be used to connect to the T1K–MODBUS base controller's RJ12 serial port.


T1K-MODBUS Setup Tool
T1K-MODBUS Setup Tool
Ver.1.0.8
1. Connect the serial port of the T1K-MODBUS to a com port on your PC.
2. Select the com port # on your PC.
Com port #
1
2
3. Connect this setup tool to T1K-MODBUS
Connect (C)
Copyright (C) 2001 Team PDK All rights researved

Configuring the MODBUS Port

The following window will be displayed when the Tool is communicating with the base controller's RJ12 serial port.



Appendix A
I/O Module Hot Swap

A

In This Appendix. . . .

— T1K–MODBUS I/O Module Hot Swap Feature

T1K–MODBUS I/O Module Hot Swap Feature

The “Hot Swap” feature allows Terminator I/O modules to be replaced with Terminator I/O system power ON. Be careful not to touch the terminals with your hands or any conductive material to avoid the risk of personal injury or equipment damaged. *Always remove power if it is equally convenient to do so.*

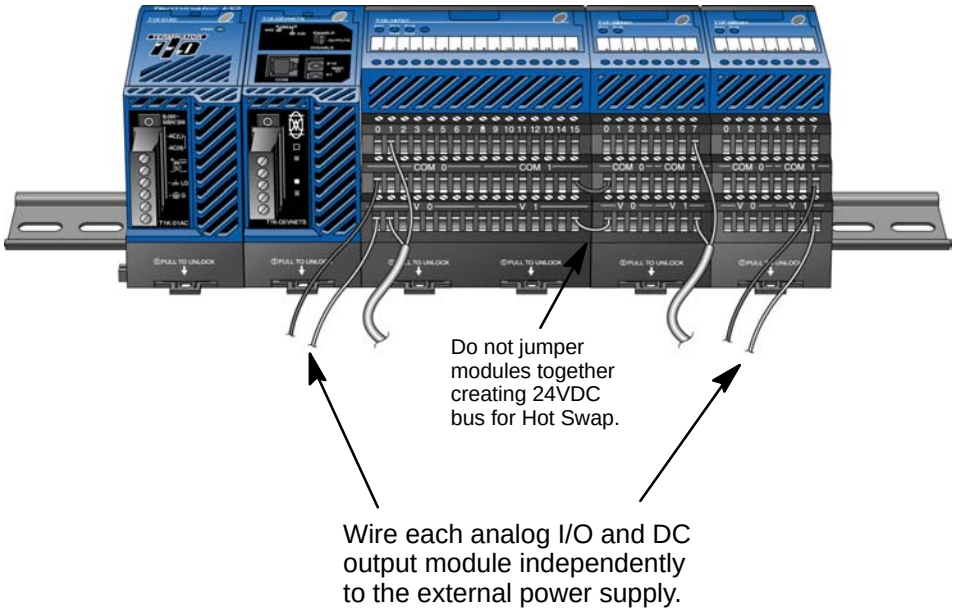
WARNING: Only authorized personnel fully familiar with all aspects of the application should replace an I/O module with system power ON.

The following module types can be “Hot Swapped”.

Module	
Power Supply	No
Base Controller	No
I/O Modules (discrete / analog)	Yes

Check External 24VDC Wiring Before Hot Swapping!

Before “Hot Swapping” an analog I/O module or a DC output module in a Terminator I/O system, make sure that each of the analog I/O and DC output module’s 24VDC and 0VDC base terminals are wired directly to the external power supply individually (see diagram below). If the external 24VDC / 0VDC is jumpered from base to base in a daisy chain fashion, and an analog I/O or DC output module is removed from its base, the risk of disconnecting the external 24VDC to the subsequent I/O modules exists.


Do not jumper modules together creating 24VDC bus for Hot Swap.
Wire each analog I/O and DC output module independently to the external power supply.

Hot Swap: I/O Module Replacement

The following steps explain how to “Hot Swap” an I/O module.

1. Remove I/O module from base. (If necessary, refer to the Terminator I/O Installation & I/O Manual for steps on removing an I/O module).
2. The T1K–MODBUS DIAG LED will turn ON.
3. Install a new I/O module with the **exactly the same part number**.
4. Verify that the T1K–MODBUS Base Controller LEDs have returned to normal.

Outputs Enable/Disable Switch

A feature that may be used in a non–continuous process application is the Outputs Enable/Disable switch. The switch is located on the front of the T1K–MODBUS base controller. This feature may be used at a convenient time during the process application to replace an I/O module.

When the switch is in the Disable position:

- all outputs are Disabled (OFF)
- the Base Controller’s output status memory is cleared
- the Base Controller ignores any outputs command from the Master Module

Appendix B: Analog Output Module Configuration

B

In This Appendix. . . .

— Analog Output Module Control Byte

Analog Output Module Control Byte

The Terminator I/O analog output modules are configured using the **Module Control Byte** located in the most significant byte of the most significant word of channel 1 of the module. The “I/O Memory Map and Analog Module Resolution” chapter in the Terminator Installation and I/O Manual (T1K–INST–M) covers memory mapping for the Terminator I/O modules.

Channel 1 Memory Map of 8&16-Channel Analog Output Module (T1F–08DA, T1F–016DA)									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	not used								Byte3
	Module Control Byte								Write Byte 4

Module Control Byte of 8&16-Channel Analog Output Module (T1F–08DA, T1F–16DA)									
Decimal Bit	31	30	29	28	27	26	25	24	Read/Write
Octal Bit	37	36	35	34	33	32	31	30	
Bit 24	**Outputs Enable** 0 = All outputs OFF 1 = All outputs Enabled								Write
Bit 25	**Unipolar / Bipolar** 0 = Unipolar selected 1 = Bipolar selected								Write
Bit 26	**5V / 10V Range** 0 = 5V range 1 = 10V range								Write
Bit 27	**0 – 20mA / 4–20mA Range** 0 = 0 – 20mA range 1 = 4 – 20mA range								Write
Bit 28 – 31	Reserved for system use								–